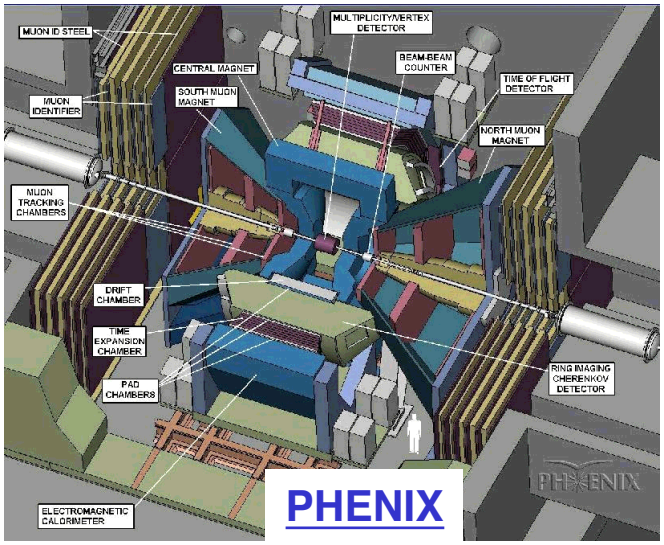
Funding & Schedule Outlook For R&D Projects

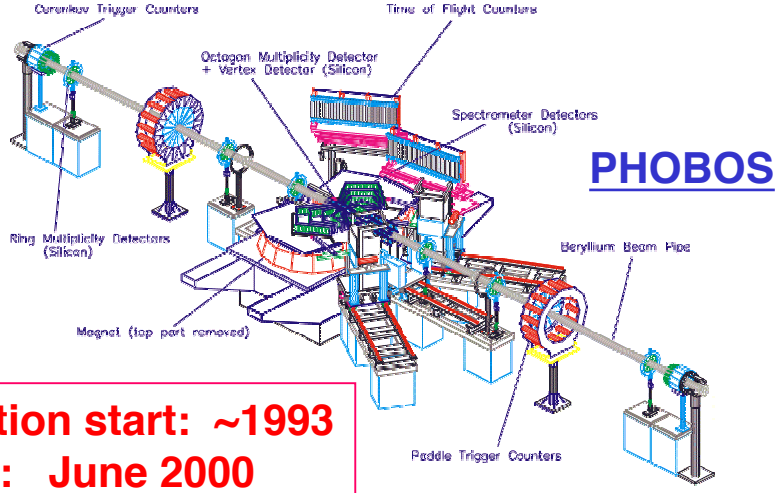
T. Ludlam

RHIC Detector Workshop

Nov. 13-14, 2001

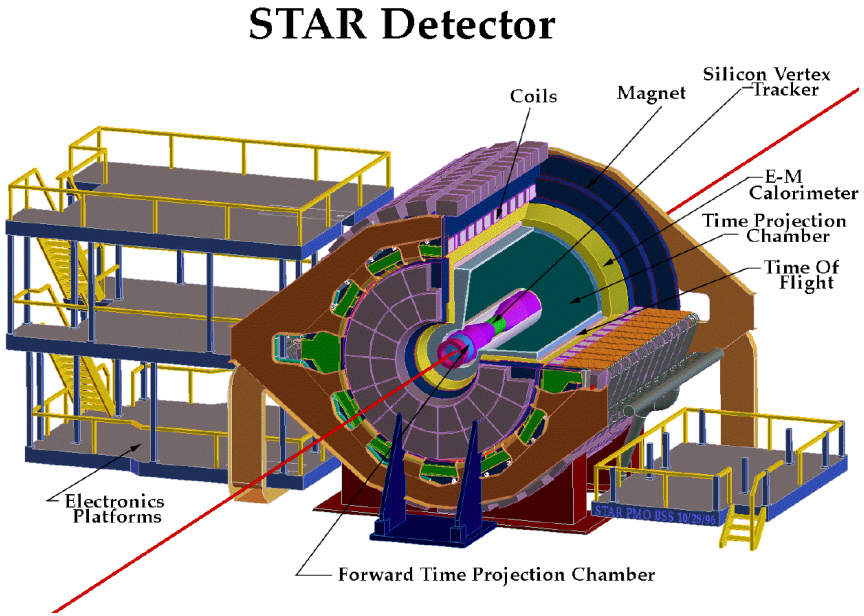
RHIC Detector Suite: The baseline detectors

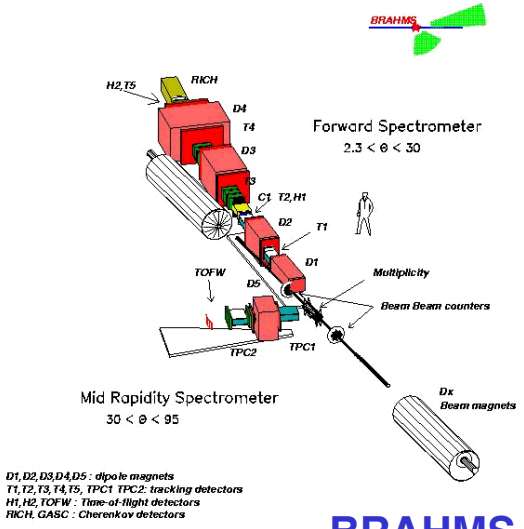




PHOBOS

Construction start: ~1993
First data: June 2000





BRAHMS

The urgency of an R&D program:... One example from the dawn of RHIC:

Timescale for Integrated Circuit readout electronics

The Problem:

Huge number of readout channels…

No longer feasible to store signals with delay cables.

Technology for analog pipelines existed, but major effort required to develop IC's for specific RHIC applications.

July, 1988 RHIC Workshop
working group: Bill Cleland et al.

1989	Design Start
1990	First chip element prototypes
	Start system design
1991	Complete chip element prototyping
1992	System prototypes
	Full bench tests
1993	Early production units
	Test beam studies
	Design refinements
1994	Full production
	Installation into detector elements
	Calibration in test beams
1995	Detector systems tests
	Installation into full detector

Development for the Baseline Detectors:

RHIC Project Detector R&D Funding
1990 - 1995

R&D Effort	FY 90 $	FY 91 $	FY 92 $	FY 93 $	FY 94 $	FY 95 Plan	Total
Total Generic	1,121,437	1,620,751	215,000	20,000	50,000		3,027,188
Total STAR			1,125,000	1,267,000	1,467,365	1,100,000	4,959,365
Total PHENIX			1,200,523	1,463,984	1,147,300	1,000,000	4,811,807
Total PHOBOS				288,000	340,000	200,000	828,000
Total Allocations	1,121,437	1,620,751	2,540,523	3,038,984	3,004,665	2,300,000	13,626,360
Administration & BNL Support	228,563	331,249	269,477	376,016	450,335	296,000	1,951,640
R&D Total	1,350,000	1,952,000	2,810,000	3,415,000	3,455,000	2,596,000	15,578,000

This Represents ~15% of the Baseline Construction Cost

Running for the "Discovery Phase" is presently underway

Heavy Ions:

- Pion spectra to P_t ~20 GeV/c
- Many thousands of J/ψ

Several hundred μb^{-1} for Au-Au collisions

At design luminosity, this is a 10 week run at a single energy point.

With energy scan… 30 weeks

+

- Light ion runs (2 - 3 species)
- p A (dA) runs

RHIC Spin:

- pp running (200 & 500 GeV)

~ 1000 pb^{-1} total pp running

This program takes us through 2005...

Near-term upgrades… 2002 - 2005

Machine: 4x luminosity improvement

Squeeze the parameters of the existing machine…

Detectors:

- Full Spin Capability… complete STAR EM Calorimeters; PHENIX Muon Arms
- Small, Ongoing Projects…

  e.g. PHENIX TRD upgrade; Muon Anode readout; STAR Silicon Strip Detector
- Improved triggers and bandwidth; increased RCF capacity

These projects require little or no development.

RHIC II… Beyond the Exploratory Phase
A more powerful "Nuclear QCD" machine:
AA pA pp (spin)

High P_t and Q^2:

- Leading particle spectra to P_t ~30 GeV/c
- Direct photons to $P_t > 20$ GeV/c
- Photon-tagged jets
- Flavor tagging of jets (PID at high P_t)
- Drell-Yan at M ~5 GeV

Rare processes:

- Many x1000 upsilons
- W production in AA pA pp

Difficult fundamental observables:

- Open charm
- Low mass lepton pairs; Low P_t Direct Photons
- Observables at forward rapidity for spin and pA physics

Candidate Upgrades to Address These Needs

- PHENIX:
  - Precision vertex tracker (silicon)
  - Compact Inner TPC
  - Hadron Blind Detector (Dalitz rejection)
  - PID at high Pt (Aerogel)

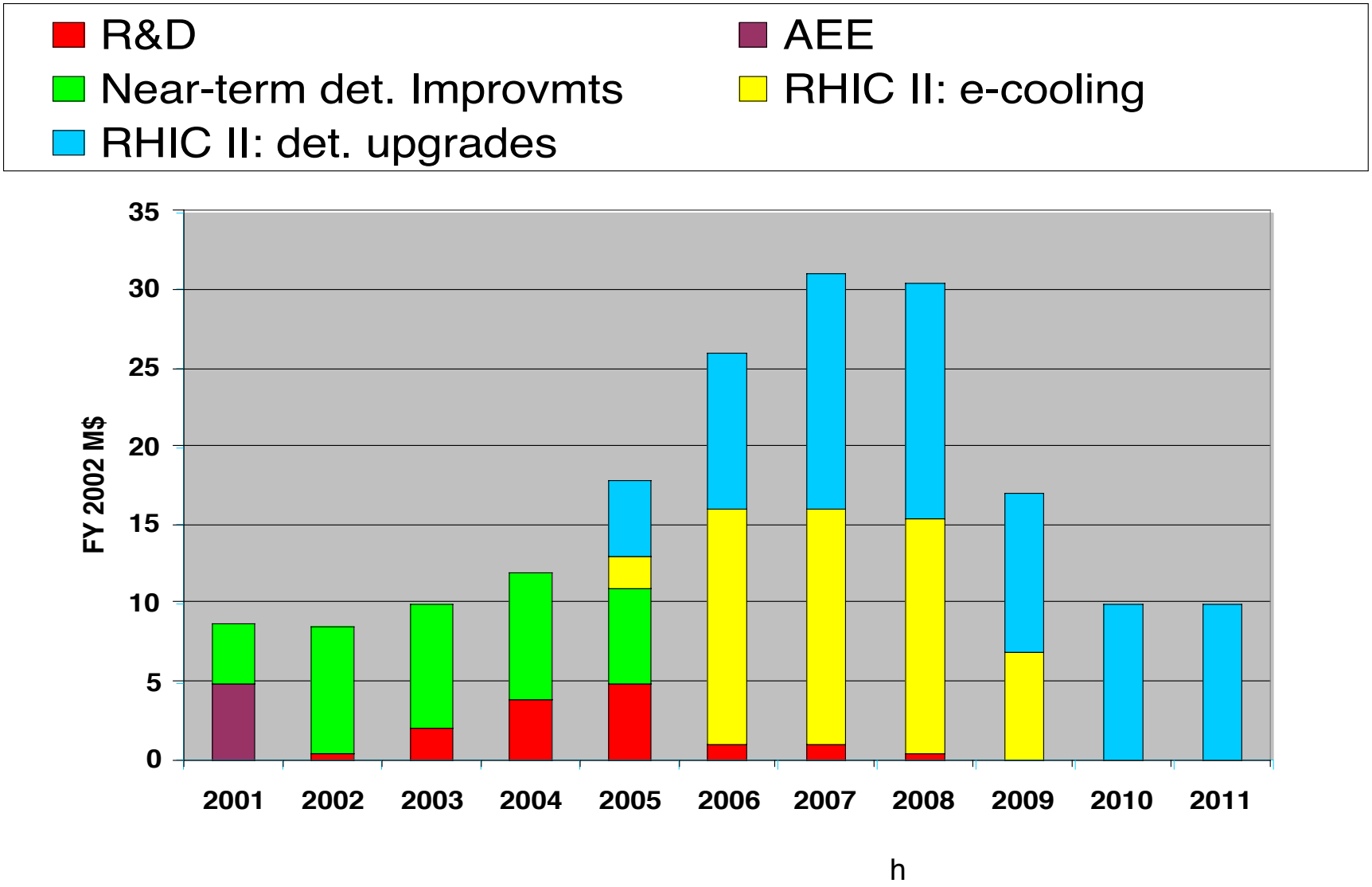
- STAR:
  - TPC replacement
  - Precision inner tracker
  - Precision forward tracker (silicon)
  - Transition Radiation Tracker (4 pi)
  - Central RICH Barrel

- PHOBOS
  - Microvertex detector (silicon)
  - + electron ID

- All Detectors: Upgraded Data Acquisition and Trigger

There are no detailed cost estimates, but a "realistic" upgrade plan would cost ~$80M in construction funds for the RHIC detectors.

Proposed RHIC upgrade funding



Straw-Man Exercise for NSAC Long Range Plan:
Proposed Equipment Funding
RHIC Upgrades

A. *This continues the existing rate of detector equipment funding:*

Implement planned detector upgrades to accommodate short-term luminosity improvements

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	Total
Short-term improvements	8.0	8.0	8.0	6.0							30.0

B. *This is the RHIC-II luminosity upgrade initiative: machine (electron cooling) and detectors, including R&D:*

Luminosity upgrade [RHIC II]	**FY02**	**FY03**	**FY04**	**FY05**	**FY06**	**FY07**	**FY08**	**FY09**	**FY10**	**FY11**	**Totals**
Electron Cooling				2.0	15.0	15.0	15.0	7.0			54.0
RHIC II Detector Upgrades				5.0	10.0	15.0	15.0	15.0	10.0	10.0	80.0
Subtotals		0.0	0.0	7.0	25.0	30.0	30.0	22.0	10.0	10.0	134.0
RHIC II R&D [Operating funds]											
Machine R&D		1.0	2.0	3.0							6.0
Detector R&D	0.5	1.0	2.0	2.0	1.0	1.0	0.5				8.0
Subtotals	0.5	2.0	4.0	5.0	1.0	1.0	0.5				14.0
Total RHIC II	0.5	2.0	4.0	12.0	26.0	31.0	30.5	22.0	10.0	10.0	148.0
Total Upgrades	8.5	10.0	12.0	18.0	26.0	31.0	30.5	22.0	10.0	10.0	178.0

This is the assumed ramp-up of luminosity from the Au-Au design value…

The first factor of 4 is funded from the on-going operations budget. The final factor of 10 is RHIC II:

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Au-Au Luminosity	L_0	$2xL_0$	$4xL_0$	$4xL_0$	$4xL_0$	$4xL_0$	$4xL_0$	$4xL_0$	$40xL_0$	$40xL_0$

Funding in 2002

There is not yet a funded "program" in place, but work is underway…

- PHENIX, PHOBOS, and STAR each have well-organized upgrade plans, and teams are being formed to advance them.

- Modest support for start-up work is being provided at BNL, LANL, LBL with Laboratory funding.

- Significant effort by PHENIX collaborators in Japan:
  - US-Japan funding, through KEK…
    Hope to achieve a level of ~$1M/year for R&D and upgrades
    Work in progress on Aerogel development

  - STA funding, through RIKEN…
    Focus on Spin
    Plan to obtain ~$1M/year for development and construction of a Silicon tracker for PHENIX. R&D is underway

Funding for 2003 and Beyond

Seven years have passed since the end of Detector R&D funding supported by the RHIC Project. This program was essential for the physics capability of he baseline detectors.

Despite grim budget news, this is a critical time to plan and implement an R&D effort for the next phase.

Important to identify the most essential R&D needs…
with a well organized plan,
and coordinated efforts where common interests exist,
so that limited resources can be applied as effectively as possible.